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Effects of pulsation type (alternate and simultaneous) on mechanical milking of dairy goats (I): A study in Alpine goats varying the system vacuum level

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ABSTRACT

The aim of this study was to assess the effect of alternate and simultaneous pulsation on milking performance (milk yield, machine stripping milk, milking duration, and average milk flow rate) of Alpine goats milked at two different system vacuum levels (38 and 42 kPa). To this end, a field study was carried out in a commercial farm of Northern Italy. A pre-experimental period was carried out and 164 goats with a similar parturition date were selected and distributed into two similar subplots of 82 goats according to their values of milk yield and milking duration. The experiment lasted 24 d and was laid out as a split-plot design. Each treatment lasted 3 days. Once every combination (2 pulsation types × 2 vacuum levels) was tested (Experiment 1), the same experimental design was repeated in reverse order (cross-over design) to control the effect of lactation progress on the results (Experiment 2). Milk traits regarding milking performance (milk yield, machine stripping milk, milking duration, and average milk flow rate) and variables related to vacuum level in the milking cluster (vacuum in the short milk tube and vacuum fluctuation in the short milk tube) were recorded during morning and afternoon milkings. Results showed that the use of alternate pulsation reduced the vacuum fluctuations and increased the average vacuum in the short milk tube. Moreover, when a higher system vacuum level (42 kPa) was set, the use of alternate pulsation reduced the milking duration. We concluded that the use of alternate pulsation offers some advantages compared to simultaneous pulsation in high milk flow conditions.

1. Introduction

Traditionally, milking parlours were designed implementing one pulsator per two or more milking units to limit the investment costs (simultaneous pulsation). In this case, the opening and closing cycles of both teat cup liners occur at the same time. However, it is possible to install one pulsator with four channels per two milking units (alternate pulsation), which milking and massage phases can occur alternately in both teat cup liners of each milking unit.

In studies carried out on dairy cows it has been observed that the use of alternate pulsation during milking could have some advantages compared to the use of simultaneous pulsation. A reduction of the milking duration and the vacuum fluctuations were observed respectively by Gleeson et al. (2004) and O'Callaghan (2004) when the alternate pulsation was used. However Gleeson et al. (2004) did not find significant differences in teat tissue changes after machine milking or in milk yield between both types of pulsation.

In dairy ewes, Billon (2004) pointed out that the use of alternate pulsation is preferable compared to simultaneous pulsation when small diameter short milk tubes and low capacity claws are employed. According to this author, this type of pulsation avoids the complete filling of these claws, reducing the vacuum fluctuations (difference between maximum and minimum vacuum level at teat-end). Thus, the use of alternate pulsation would imply more consistent milk flow at this point.

In dairy goats, studies regarding the type of pulsation and milking performance are limited. Díaz et al. (2005) showed a reduction of milking duration (4.6 vs 3.2 min) and lower values of somatic cell count (1.1 × 106 vs 1.8 × 106 cells/mL) with alternate pulsation respect to simultaneous pulsation in a study on Florida goats (autochthonous Spanish breed) milked using a high-line milking machine.

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Several studies (Lu et al., 1991; Sinapis et al., 2006) pointed out that reductions of the system vacuum level (from 52 kPa to 44–45 kPa and from 44 to 45 kPa to 36–38 kPa, respectively in high line and low line milking parlours) were related to lower somatic cell count values.

In the literature there is a lack of studies on the effect of pulsation types (alternate and simultaneous) combined with different system vacuum levels or milk pipeline heights on the efficacy of machine milking, vacuum stability and teat status. To this end, 2 studies in dairy goats were proposed. The first of them, which includes two experiments and whose results are presented in this article (Part I), was carried out in Italy using Alpine breed goats and studied the effect of pulsation type in combination with 2 system vacuum levels. The second work, which included 4 experiments, was carried out in Spain using Murciano-Granadina breed goats and studied the effect of pulsation type at the onset and end of lactation, utilising 2 milk line heights (high and low). The outcomes will be presented in the second article (Part II).

Specifically, the aim of this study was to investigate if any combination of alternate or simultaneous pulsation with two system vacuum levels (38 and 42 kPa) could provide a benefit on milking performance (milk yield, machine stripping milk, milking duration, and average milk flow rate) of Alpine goats and on vacuum level measured in the short milk tubes during milking (vacuum in the short milk tube and vacuum fluctuations).

2. Materials and methods

2.1. Facilities and animal handling

The field study was carried out at the commercial farm Castello di Roccaforte located in Roccaforte Ligure, Piemonte (Northern Italy). Alpine goats were fed twice a day with the same ration (unifeed), and water was offered ad libitum. Goats were milked twice a day, as usual in this breed and in this geographical area, at 6:30 and at 15:30.

A Royal® (Bellagio, Italia) low line side-by-side milking parlor with 16 milking clusters (Vanguard ITP205, InterPuls®, Albinea, Italy) on each side was used. The milking machine was equipped with 16 four-channels electronic pulsators (LE 30, InterPuls®, Abinea, Italy), 8 per row of milking stalls. Flow-based automatic cluster removers (ACR) were coupled with electronic milk meters (AfiFree, Afimilk Ltd., Israel) and set to shut off the system vacuum with a milk flow threshold of 150 g/min, a delay time of 10 s and a minimum milking duration of 60 s. Each milking cluster was equipped with RF-ID antennas for electronic identification of animals fitted with an electronic tag on the leg bands. A flock management software suite (AfiGoats™, Afimilk Ltd., Israel) helped manage the milking and electronic identification of the animals. A pulsation rate of 90 cycles/min and a pulsation ratio of 60:40 were set.

2.2. Experimental design and variables analyzed

2.2.1. Experimental design

A group of 180 goats with a similar parturition date and the same management conditions was involved in the experiment. A pre-experimental period took place in the 8th ± 1 postpartum week. The milking duration and the milk yield of each animal were recorded on two days at four consecutive milkings (two in the morning and two in the afternoon). Moreover, in the morning milking of the first day, animals with asymmetric udders were recorded and a visual examination of the milk from each mammary gland was performed. A total of 164 goats free of clinical mastitis, with symmetric udders, daily milk yield greater than 1 kg, and milking duration shorter than 6 min were selected and randomly divided into two subplots according to parities, milk yield and milking duration.

Four treatments were tested by using different combination of pulsation type (alternate or simultaneous) and system vacuum of the milking machine (38 kPa or 42 kPa: 1) alternate pulsation with 38 kPa (ALT38); 2) alternate pulsation with 42 kPa (ALT42); 3) simultaneous pulsation with 38 kPa (SIM38); 4) simultaneous pulsation with 42 kPa (SIM42). Milkings with simultaneous pulsation were performed connecting both channels of the same side of the pulsator to the teatcups of one milking cluster. Milkings with alternate pulsation were performed connecting two channels of different sides of the pulsator to the teatcups of one milking cluster. The vacuum level was changed by turning the adjustment screw of the vacuum regulator (Stabilvac 6000, InterPuls®, Abinea, Italy). The accuracy of the vacuum gauge was checked at the beginning of each treatment using a PulsoTest Comfort® device (GeaFarm Technologies®, Bönen, Germany). The pulsation characteristics were checked using Vadia® devices (Biocontrol®, Rakkestad, Norway). Pulsation cycle phases (A, B, C, and D) from the milking time test were the following: 6.9%, 50.6%, 6.1% and 36.4% (ALT38); 7.8%, 49.1%, 6.6% and 36.5% (ALT42); 7.0%, 50.5%, 6.1% and 36.4% (SIM38); 7.4%, 49.2%, 6.6% and 36.8% (SIM42).

The experimental period lasted 24 d and was laid out as a split-plot design with pulsation type (alternate or simultaneous) as whole plot. System vacuum level (38 or 42 kPa) was crossed over between subplots within the plot. Each treatment lasted 3 d. Once every combination (2 pulsation types x 2 vacuum levels) was tested (Experiment 1), the same experimental design was repeated in reverse order (cross-over design) to control the effect of lactation progress on the results (Experiment 2). The experimental design scheme is shown in Table 1.

During each three-day period, every subplot of animals was milked according to the same conditions. The first day was used to habituate the animals to the experimental conditions and to record the variables related to vacuum levels. The second and third day were used to collect data from the morning milking and from the afternoon milking, respectively (sampling days).

2.2.2. Milking routine

The milking routine followed on each sampling day included cluster attachment, machine milking (recording of milk yield and milking duration), and automatic cluster removal. The milking cluster was reattached within 30 s of automatic cluster removal and downward pressure applied by the milker to prevent occlusion of the teat sinus. Machine stripping continued until there was no milk flow. If cluster falls occurred during machine milking, due to kicks or slips, cluster were quickly reattached. Milking routine accomplished during the adaptation days was the same, but no machine stripping was performed, as usually occurs in commercial farms when ACR are installed. Once milking was finished, teats were immersed in 0.5% iodine solution.

2.2.3. Variables related to milking performance

Milk yield (kg) and milking duration (min) were respectively the amount of milk extracted and the time elapsed from cluster attachment to automatic cluster removal. Machine stripping milk (kg) was the amount of milk extracted using a second cluster attachment and manipulation of the udder until totally empty. These three variables were recorded on AfiFree® devices (AfiMilk Ltd., Israel) and their values registered and stored using AfiGoats® software (AfiMilk Ltd., Israel). From values of the milk yield and milking duration, the average milk flow rate was calculated (average milk flow rate = milk yield/milking duration). Every variable was recorded in the morning and evening milkings separately.